Non-Auditory Effects of Noise Exposure

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Non-Auditory Effects Of Noise

- Physiological
  - Stress Arousal
  - Sleep Disturbance
- Psychological
  - Annoyance
  - Behavioral
- Communication
- Cognition
- Intervention strategies

Physiological: Stress

- Noise is biological stressor
  - Sympathetic nervous system
    - Activated at **65-70dBA**

Well below the level of auditory hazard!!!

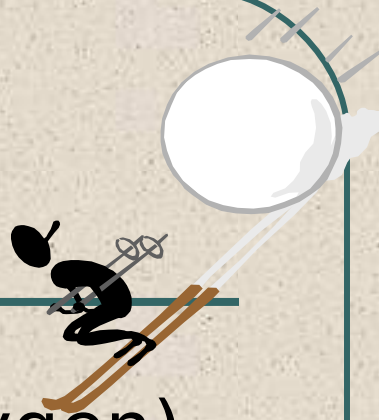
Physiological:Stress

- What is it?
  - Body's reaction to any stressor requires an adjustment or response
    - The reaction to stress can be physical, mental or emotional
    - Causes of stress can come from your body, your thoughts, or the **environment**
    - **Whatever the cause of stress, real or imagined, the body's response is real**

Autonomic Nervous System (ANS)

- Autonomic Nervous System (ANS)
  - Sympathetic – “Fight or Flight”
  - Parasympathetic – reverts system back from “Fight or Flight” to more relaxed

Sympathetic Nervous System



- Fight or Flight (More Energy & Oxygen)
  - Heart beats faster and pumps more blood per beat
  - Constrict blood vessels in organs not essential to fight or flight (e.g. gastrointestinal tract)
  - Waste elimination process decreased
  - Breathing becomes deeper, faster & more efficient
  - Pupils enlarge improving visual sensitivity
  - Secretion of adrenalin reinforces and sustains the sympathetic effect
  - Liver releases glucose to fuel action

Parasympathetic Nervous System

- Normalize functions of organs after Fight or Flight
  - Heart rate slows
  - Blood vessels expand
  - Gastrointestinal function increase
  - Bronchial constrict
  - Pupils constrict

Physiological: Stress

- Physical Basis
  - Homeostasis
    - Metabolic equilibrium between SNS & PNS
  - Over stimulating or tranquilizing leads to imbalance
  - Release of powerful hormones intended for short term duty
  - Chronic stimulation leads to illness

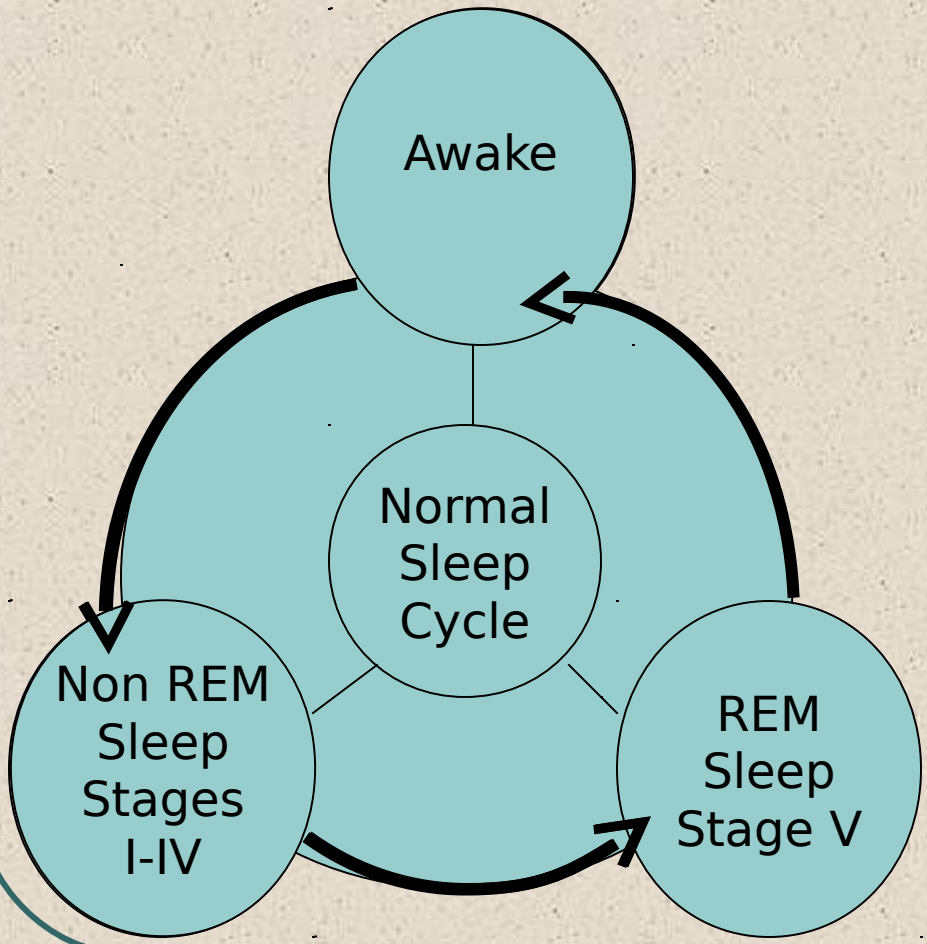
Physiological: Stress

- Stress to some of the leading causes of death
  - Heart disease, cancer and lung ailments
    - 75-90% of all doctor's office visit stress related ailments and complaints
- Per OSHA the cost of stress in the work place
  - 300 billion annually (lost work hours due to absenteeism, reduced productivity, workers' compensation)

Health Effects Associated with Stress

- Cardiovascular problems
  - Hypertension
  - Increased risk of heart attack
- Weakened immune system
- Gastrointestinal problems
  - Ulcers

Physiological: Sleep Disturbance



- Disrupts Normal Sleep cycle
  - Longer to fall asleep
  - Shortens deep and REM sleep stages
  - Arousal reaction & Awakening
- Vegetative disturbances persist after subjective adaptation
- Decreased psychomotor function

Physiological: Sleep Disturbance

- 60dB(A) Awakening
- 45dB-55(A) Vegetative arousal (refrigerator)
- Sleep disturbance is influenced by
  - Characteristics of the noise
  - Individual differences
  - Age

Psychological: Annoyance

- Annoyance
  - A response to noise rather than an auditory perception of it
    - Closing a window when noise outside is too loud
- Threshold of annoyance
  - 50-55dB(A)
- Noise is more likely to be annoying if
  - Random
  - Higher pitched
  - Combined with warmer climate
  - Occurs at night

Psychological: Annoyance

- Annoyance is subjective
  - Noise is likely to be an annoyance if one perceives:
    - Not necessary
    - People causing the noise do not care about its effects on those exposed to it
    - The noise is not important to the economic and social success of the community

Psychological: Social Behavior

- Increased aggressiveness
  - Especially in those pre-disposed to aggressive behavior
- Decrease helping behavior
- Problems with interpersonal relationships

Cognition

- Functions most affected
  - Reading comprehension
  - Attention span
  - Problem solving
  - Memorization
  - Job performance

Communication

- Above 55-60dB(A) background noise interferes with communication
- Armor Crew Performance (Garinther & Peters, 1990)
  - Mission time completion increased from 40-90 seconds
  - Crew killed by enemy increased from 7% to 28%
  - Targets correctly identified decreased from 98% to 68%
- More taxing for children, elderly & hearing impaired

Do we get used to it?

- Habituation
  - Dissipation of response from repeated exposure
- Adaptation
  - Voluntary effort to adjust (e.g. sound proofing)

Non-Auditory Effects of Noise

- Job dissatisfaction
- Somatic complaints (e.g. headaches)
- Anxiety and post work irritability
- Post work irritability
  - Impatience
  - Nervousness
  - Generally inability to unwind

What Can We Do?

- Release stress hormones
  - Exercise
- Reduce tension
  - Relaxation
    - Breathing exercises
    - Muscle relaxation exercises
    - Yoga
    - Tai- Chi
    - Autogenic exercises
      - Images of relaxed state

Conclusion

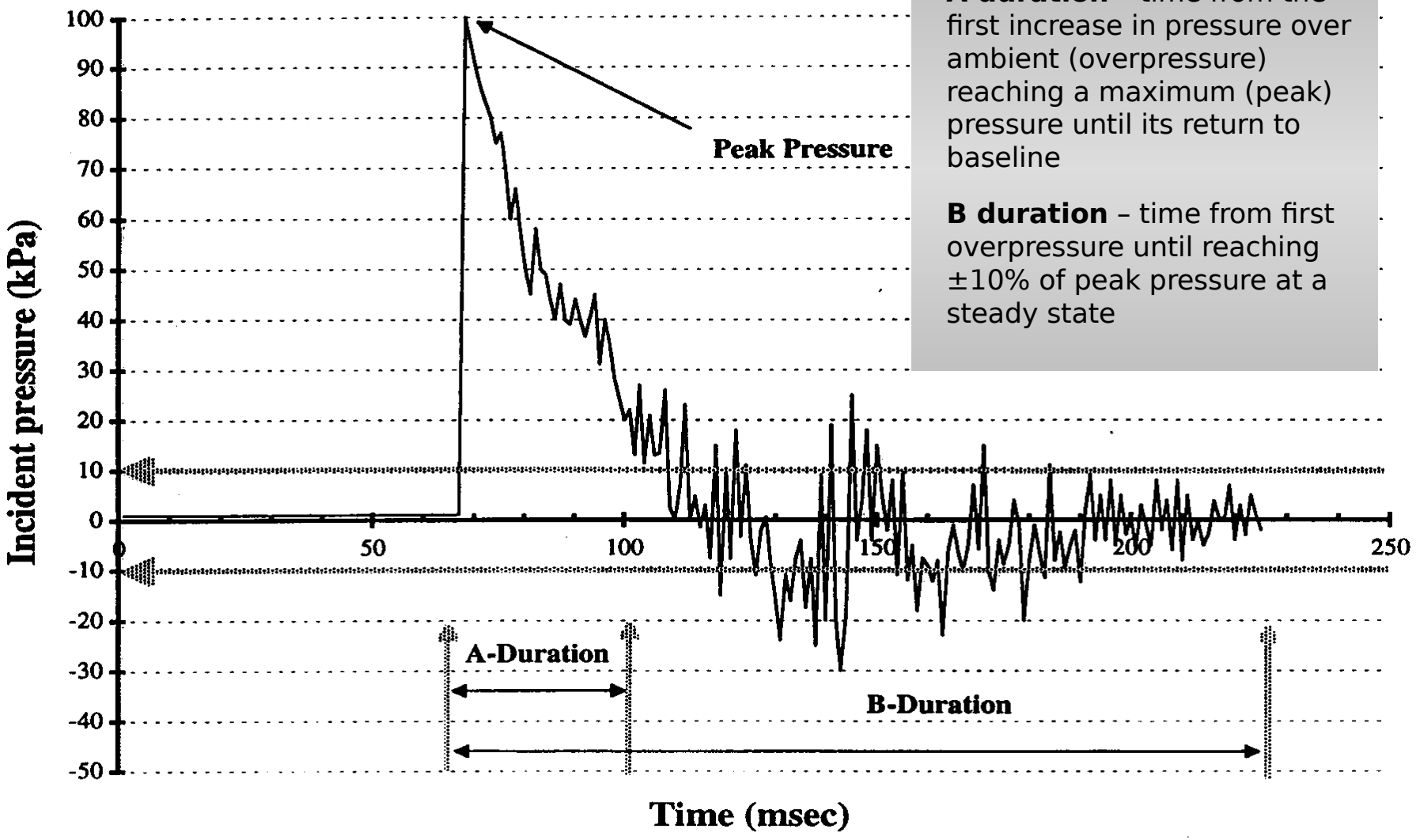
- Noise is a
  - biological stressor
  - Annoys, awakens, angers and frustrates
  - Effects performance
  - Leads long term health effects
- Auditory system most important sensory warning system
    - On duty 24/7
- Include non-auditory effects of noise hearing conservation message

Questions?????

Website

- Stress Intervention Strategies
  - http://www.chclibrary.org/micromed/00066670.html

Blast Wave



A duration – time from the first increase in pressure over ambient (overpressure) reaching a maximum (peak) pressure until its return to baseline

B duration – time from first overpressure until reaching ±10% of peak pressure at a steady state

Types of Blast Injury

- Primary Blast Injury
  - Damage to internal organs without visible external signs of injury that occurs as a direct result of the pressure wave contacting the body
- Secondary Blast Injury
  - Damage to the body with visible external signs of injury that occurs as a result of contact with objects that are propelled by the blast wave
- Tertiary Blast Injury
  - Blast wave displacing the body and the body contacting some object in the environment

Blast Injuries

- Noise
  - The “auditory” component
  - Target Organ(s): inner ear
  - Outcome: temporary to permanent hearing loss

- Blast Overpressure
  - The “non-auditory” component
  - Target Organ(s): gas-containing organs (lungs trachea, GI tract, ear)
  - Outcome: performance problems, mild to sev hemorrhage

Non-Auditory Noise Effects

- Steady State Noise
  - 120 dBA Discomfort
  - 140 dBA Pain
  - 160 dBA Ear drum rupture
- Impulse
  - 185 dBP Ear drum rupture
  - 200 dBP Lung rupture & embolism

Blast Injuries

- Signs of lung injury
  - Present early after exposure
  - Dyspnoea
    - Difficulty breathing
  - Cough
    - Dry to productive with frothy sputum
  - Haemoptysis
    - Coughing up blood
  - Chest pain or discomfort

Blast Injuries

- Signs of gastro-intestinal tract injury
  - Manifest later usually when complications are advanced
  - Abdominal pain, nausea, vomiting
  - Rectal & testicular pain
  - Tenesmus
    - Constant feeling of the need to empty bowel

Blast Injury

- Threshold of unsafe levels in humans
  - 12 blasts, 182 dBP, 8-9ms no abnormalities
  - With higher peak pressures, large hemorrhages not only in tracheae but also in the lungs due contusions

Blast Injury

- Mechanism primary blast injuries
  - Stress waves
    - Pressure waves like sound
    - Travel slightly faster than speed of sound (340.29 m/s, 1100 feet/second)
    - Height amplitude
    - Responsible for the lung & small bowel injury

Blast Injury

- Mechanism primary blast injuries
  - Shear waves
    - Long duration, low velocity, transverse waves
    - Deformation of body wall and compression of structures
    - Different inertias causes tearing of structures from attachments
    - Responsible for large bowel injuries

Blast Injury

- Threshold of unsafe levels
  - Sheep studies
  - Indicator of lung damage
    - Bleeding from very small lesions of capillaries, harmless, self healing
  - 5 exposures at 188 dBP for durations of 5ms
  - Or higher pressures with shorter duration with 100 exposures threshold value was at 184 dBP

Non-Auditory Injuries

Blast Energy

Lung Surface Damage

Deep Lung Damage

- The presence & extent of pulmonary fat embolism in surviving blast victims seems to be related to mortality

Diffuse Aleveolar Over distension

Pulmonary Hemorrhages

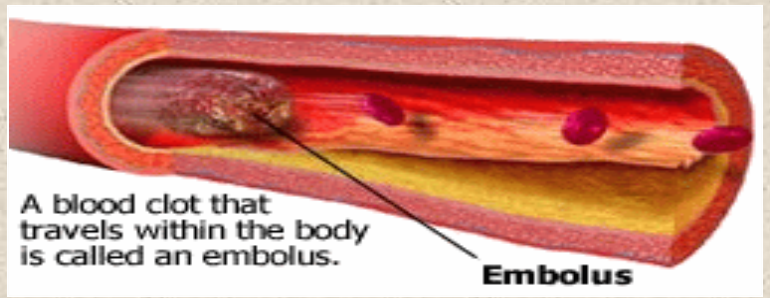
Venous Air Embolism

Bone Marrow Embolism

Pulmonary Fat Embolism*

Significance of Emboli

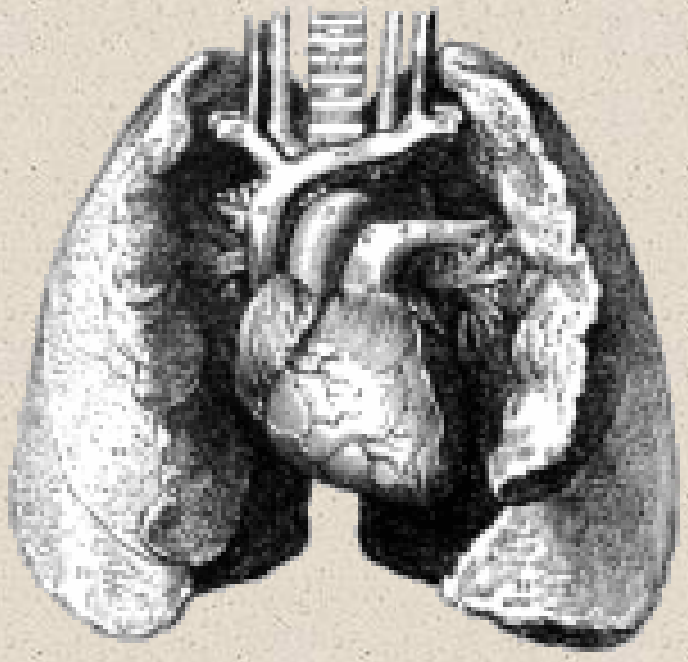
- Mechanical agitation of blast wave can:
  - Dislodge fat droplets within tissues
  - Produce an embolus in a vessel
  - Obstruct the vessel, if large enough
    - May cause heart attack or stroke



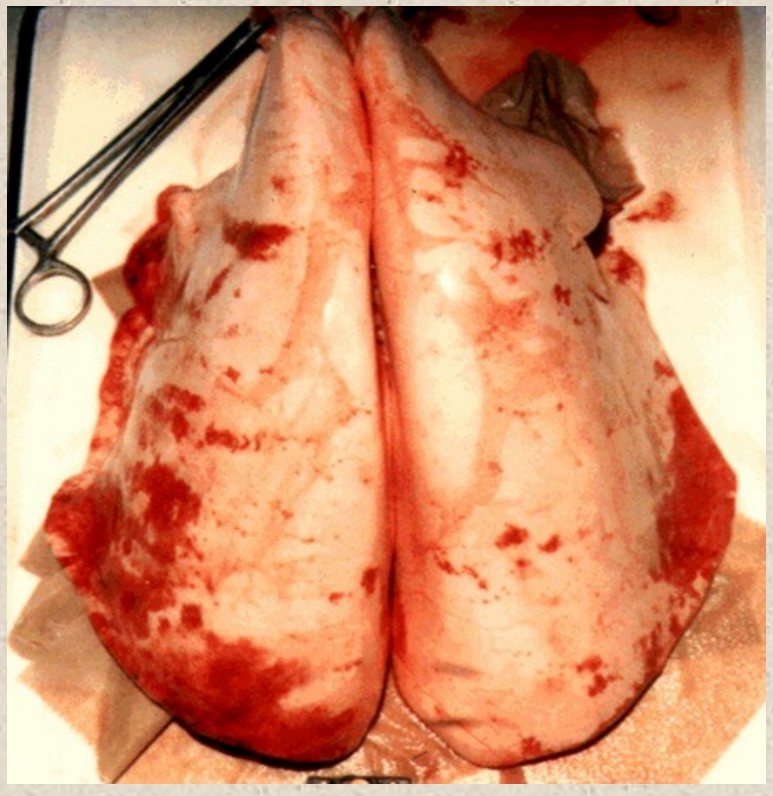
Blast Impulse

- The product of the overpressure from the blast wave of an explosion and the time during which it acts at a given point (that is, the area under the positive phase of the overpressure versus time curve.)

Non-Auditory Injuries



- Healthy



- Damaged